FORECASTING PRODUCTS TECHNICAL NOTE NO.3

THE IMPACT OF DATA ON FINE MESH FORECASTS FOR THE STORM OF JANUARY 25th 1990

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Introduction

The storm of January 25th 1990 reached its peak over the southern part of the UK between 12Z and 18Z. As the model analysis shows (figure 1), at 12Z the depression was centred over the Scottish/English border with a central pressure of 951mb. Mean wind speeds on its western and southern flanks were in excess of 50 knots in many places and gusts in excess of 90 knots were reported.

The UK Met. Office's Global Model gave guidance during the previous five days which indicated that a depression would cross the country on Thursday 25th January, although the severity of the winds was not emphasised at that stage. However, this document will focus on the performance of the Limited Area (Fine Mesh) Model which, operationally, produces forecasts for the period up to 36 hours ahead.

The Fine Mesh Model is run on a 12-hourly cycle as follows :-

00/12Z	Global Model analysis interpolated onto Fine Mesh grid
03/15Z	Assimilation
06/18Z	Intermediate assimilation and 36-hour forecast
06/18Z	Update assimilation including data received after the Intermediate run
09/21Z	Assimilation
12/00Z	Assimilation and 36-hour forecast

Boundary conditions for each assimilation in the cycle and the forecast are derived from the 00/12Z Global Model analysis used as a start field for the cycle.

Figures 2-4 show the operational Fine Mesh forecasts issued from data times 00Z, 06Z and 12Z 24th January, all verifying at 12Z 25th. As can be seen, the 24-hour forecast from 12Z 24th, although 10mb less deep than the verifying analysis, gave very good guidance to the forecaster as to the severity of the impending storm, indicating mean wind speeds in excess of 50 knots in parts of Southern England and Northern France. However, the forecasts from the 06Z 24th and particularly 00Z 24th analysis were far inferior and gave little indication of the storm's severity. This shows a similarity with the storm of October 1987. On that occasion the 24-hour forecast valid at 00Z 16th October was very poor, but the 18- and 12-hour forecasts for the same validity time were much improved, although the 18-hour forecast was not produced operationally at that time.

This document will investigate the reasons for the improvement in the forecasts of mean sea level pressure in two stages; firstly, the improvement of the 06Z forecast over the 00Z forecast and, secondly, the improvement of the 12Z forecast over the 06Z forecast. The forecasts verifying at 12Z 25th will be examined in all cases.

1. Improvement between the 00Z and 06Z 24th Forecasts

a) The 00Z operational Fine Mesh forecast (figure 2) followed a 12-hour Fine Mesh assimilation using forecast boundary tendencies from the 12Z 23rd Global Model analysis. Subsequent operational Fine Mesh forecasts used boundary tendencies from the 00Z 24th Global Model analysis. The effect of using more recent boundary tendency files was assessed by rerunning the 12-hour Fine Mesh cycle from 12Z 23rd to 00Z 24th using tendencies from Global Model assimilations at 18Z and 00Z rather than tendencies from the 12Z Global forecast as operationally. The 36-hour forecast then uses 36-hour forecast boundary tendencies rather than 48-hour forecast boundary tendencies as operationally. Figure 5 shows that using these new tendencies infact has a very small negative impact on the forecast when compared with figure 2. Hence, improved Fine Mesh forecasts after 00Z did not result from effects outside of the Fine Mesh area.

b) A test forecast was run using a 00Z Global Model analysis interpolated to the Fine Mesh grid and using boundary tendencies from the same operational Global Model analysis. The Global Model analysis was created using the Fine Mesh data time window of T-1.5 hours to T+1.5 hours. Figure 6 shows that this gave an improvement of 3mb over the 00Z operational forecast.

Having eliminated all differences in the data by using the Fine Mesh time window and having previously shown that using more recent boundary tendencies has no positive effect on the forecast, the only remaining difference in the two runs (figures 2 and 6) is the assimilation techniques used by the Global and Fine Mesh Models. Both models have operated with the Analysis Correction Scheme since June 1989, but various tuneable parameters are set to different values for the two models. In both models an observation has its maximum weight at its observation time, but in the Global Model an observation has an influence up to five hours before and one hour after the observation time. These values are halved for the Fine Mesh Model. The horizontal influence of an observation is determined by a parameter known as the Horizontal Correlation Scale and is approximately 16% larger for the Global Model than for the Fine Mesh. It is possible that these variations account for the differences between the operational 00Z forecast (figure 2) and the forecast shown in figure 6, but it is considered that further investigation into these tuneable parameters constitutes a separate study in its own right and is beyond the scope of this study.

c) An investigation was then made into the impact of data outside of the Fine Mesh time window (2230 to 0130), but within the Global Model time window (2100 to 0300). A Fine Mesh forecast was run from the 00Z Global Model analysis interpolated to the Fine Mesh grid, but using the Global Model time window. The results (figure 7) show a positional improvement and a deepening of 1mb when compared with figure 6. The probable explanation for this improvement is the inclusion of aircraft data valid between 0130 and 0300.

d) Of all data valid at 03Z, aircraft data seemed the most significant in terms of number of observations and their differences from the background field. A forecast was run from the 03Z analysis created without aircraft data (figure 8). The result is almost identical to the forecast from the 00Z Global Model analysis interpolated to the Fine Mesh grid (figure 7). Hence, it can be concluded that data other than that from aircraft used in the 03Z analysis did not have a significant impact on the forecast.

e) A forecast was then run from the 03Z Fine Mesh analysis created including aircraft data and figure 9 shows a considerable improvement on the 03Z forecast without aircraft data (figure 8). Hence, aircraft data have had a positive impact on the forecast at this stage. However, the pressure gradient to the west of the depression is still not as tight as the 06Z operational run (figure 3).

The data available for the 06Z assimilation were examined and the 06Z forecast rerun without particular data types so as to assess the impact of each on the forecast.

f) Firstly, the 06Z forecast was rerun from an analysis without bogus, surface ship reports, drifting buoys and a pilot wind report from Ocean Weather Ship Charlie. The result (figure 10) is very similar to the forecast from the 03Z data (figure 9).

g) The 06Z forecast was then rerun from an analysis without bogus, surface ship reports or drifting buoys, but with Ocean Weather Ship Charlie's pilot wind report. Figure 11 shows an improvement of 1mb when compared with figure 10 and the result is very similar to the 06Z operational forecast (figure 3).

h) Finally, the 06Z forecast was rerun from an analysis just without three bogus observations inserted to support surface observations from ships in the North Atlantic. Figure 12 shows that the inclusion of surface ships and drifting buoys improves the forecast when compared with figure 11. However, the operational 06Z forecast (figure 3) is actually slightly worse both positionally and in terms of central pressure as a result of the inclusion of these bogus observations when compared with figure 12. Hence, the bogus data has had a small negative impact on the forecast.

2. Improvements between the 06Z and 12Z 24th Forecasts

a) The operational 06Z forecast is run from an analysis using data received by 0755. However, some data, valid within the time window of the 06Z run, is received after this time. Hence the 06Z assimilation is repeated before the 09Z and 12Z assimilations to make use of these data. On this occasion many satellite sounding data, both LASS and compressed code SATEMs, became available for the 06Z update analysis, after the 06Z forecast had run. A forecast was run from the 06Z update analysis and shows a slight positional improvement of the depression centre and a deepening of 1mb over the operational 06Z forecast. See figures 3 and 13.

b) A forecast was run from the 09Z analysis and figure 14 shows another small improvement on the 06Z forecast with satellite data (figure 13). This improvement is due to further aircraft data and surface ship observations used in the 09Z assimilation.

c) On inspection of the data available for the 12Z run it was noticed that a TEMP was received from Ocean Weather Ship (OWS) Charlie just to the north of the developmental area and also from ship ONDA just to the south. This latter observation is part of the Automated Ship Aerological Program and is commonly known as an ASAP. Many surface ship reports and aircraft data were also received from the same area. Hence the 12Z assimilation and forecast were rerun without tempships, surface ships and aircraft data. The resultant field (figure 15) shows little difference to the 09Z forecast with all data (figure 14).

d) The impact of aircraft data was assessed by rerunning the 12Z forecast from an analysis without tempships and surface ships only. Figure 16 shows a very slight improvement on figure 15.

e) The 12Z forecast was then rerun without tempships only and figure 17 shows a further slight positional improvement due to the inclusion of surface ship data. However, when compared with figure 4 it is clear that the elimination of tempships alone has degraded the central pressure by 8mb and given the depression a much broader centre.

f) In an attempt to pinpoint the difference between figures 4 and 17 more specifically, three further forecasts were run. Figure 18 is a run just without tempship ONDA. Figure 19 is a run just without OWS Charlie and figure 20 a run without both tempship ONDA and OWS Charlie. It is clear that both tempships have had an impact, individually, on the forecast, but figure 20 shows the even greater combined impact of these two observations.

An examination of grid point forecast surface winds verifying at both 12Z and 15Z shows some large differences. The strongest winds experienced in the UK on 25th January 1990 were at Aberporth in south west Wales between 14Z and 15Z with a mean speed of 65 knots and a maximum gust of 93 knots. The operational 27-hour forecast verifying at 15Z indicates mean wind speeds of up to 45 knots at Fine Mesh grid points nearest and to the north and east of Aberporth. The forecast wind speeds at these grid points for the run without the two tempships are reduced by up to 25 knots. Even in the run just without tempship ONDA grid point winds are still reduced by up to 20 knots in places when compared with the operational forecast. Figures 21 and 22 show forecast surface winds (not on model grid points) for the operational forecast and the forecast without tempship ONDA and OWS Charlie.

3. Conclusions

It is clear that the improvement in the forecast from 00Z, which features a shallow depression of 979mb positioned to the east of East Anglia (figure 2), to the forecast from 12Z, when the depression was deepened to 961mb and positioned over North Wales (figure 4), was due to the combined and incremental effects of many observation types in the area of development in the North Atlantic over those 12 hours. A further significant factor was found to be the use of the Global Model analysis interpolated to the Fine Mesh grid as a start field for the four-cycle assimilation culminating in the 12Z Fine Mesh forecast. However, it is apparent that the largest single contribution to the improvement of the forecast was made by the reports of Ocean Weather Ship Charlie and ASAP ONDA at 12Z. This clearly shows the value of upper air data in the North Atlantic at a time when the ending of the Ocean Weather Ship Programme is being mooted and justification for further expenditure on ASAPs is being sought.

Operationally, the forecaster was supplied with very good guidance from the Fine Mesh Model during the afternoon of 24th January as to the impending wind strengths and a warning of widespread damaging winds was issued to the military and civilian population immediately. These two tempship data have clearly made a significant contribution to the quality of model guidance by providing vertical profiles of the atmosphere at a critical stage in the development of the severe storm which crossed the UK on 25th January 1990.

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Summary of Figures

All figures relate to the Fine Mesh model unless otherwise stated.

Figure 1 : Operational analysis 12Z 25th

Figure 2 : Operational 36-hour forecast from 00Z 24th analysis

Figure 3 : Operational 30-hour forecast from 06Z 24th analysis

Figure 4 : Operational 24-hour forecast from 12Z 24th analysis

Figure 5 : 36-hour forecast from 00Z 24th analysis using tendencies from the 00Z 24th Global analysis

Figure 6 : 36-hour Fine Mesh forecast from 00Z 24th Global analysis using the Fine Mesh time window

Figure 7 : 36-hour Fine Mesh forecast from 00Z 24th Global analysis using the Global Model time window

Figure 8 : 33-hour forecast from 03Z 24th analysis without aircraft data

Figure 9 : 33-hour forecast from 03Z 24th analysis

Figure 10 : 30-hour forecast from 06Z 24th analysis without bogus, surface ships, drifting buoys and pilot ship data

Figure 11 : 30-hour forecast from 06Z 24th analysis without bogus, surface ships and drifting buoy data

Figure 12 : 30-hour forecast from 06Z 24th analysis without bogus data

Figure 13 : 30-hour forecast from 06Z 24th update analysis

Figure 14 : 27-hour forecast from 09Z 24th analysis

Figure 15 : 24-hour forecast from 12Z 24th analysis without tempships, surface ships and aircraft data

Figure 16 : 24-hour forecast from 12Z 24th analysis without tempship and surface ship data

Figure 17 : 24-hour forecast from 12Z 24th analysis without tempship data

Figure 18 : 24-hour forecast from 12Z 24th analysis without tempship ONDA

Figure 19 : 24-hour forecast from 12Z 24th analysis without OWS Charlie

Figure 20 : 24-hour forecast from 12Z 24th analysis without tempship ONDA and OWS Charlie

Figure 21 : 24-, 27- and 30-hour forecasts from 12Z 24th operational analysis

Figure 22 : 24-, 27- and 30-hour forecasts from 12Z 24th analysis without tempship ONDA and OWS Charlie

FIGURE 1

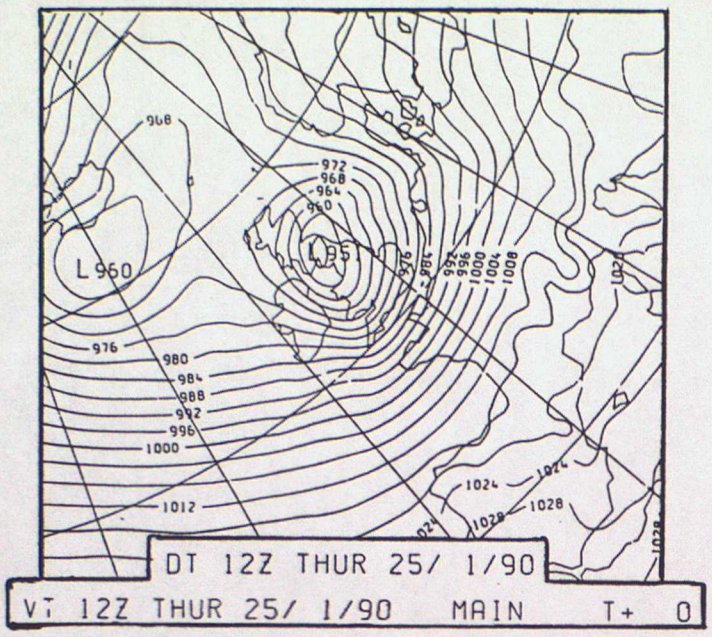
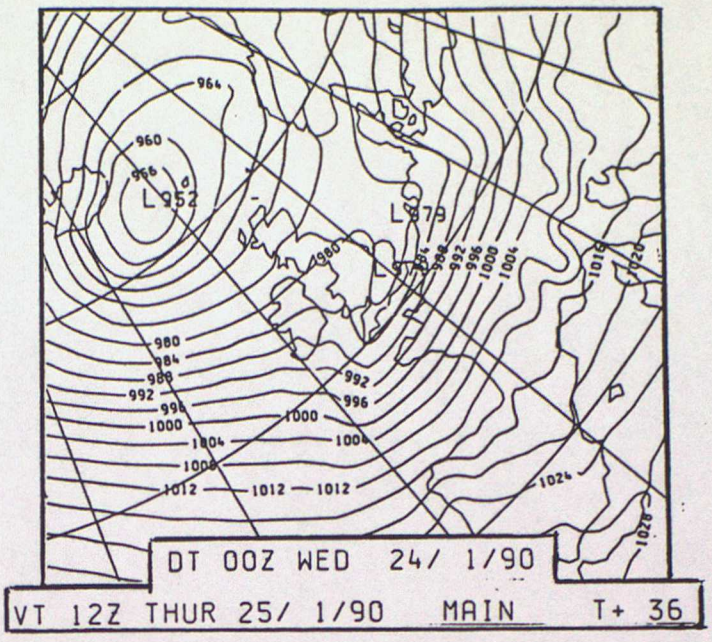


FIGURE 2



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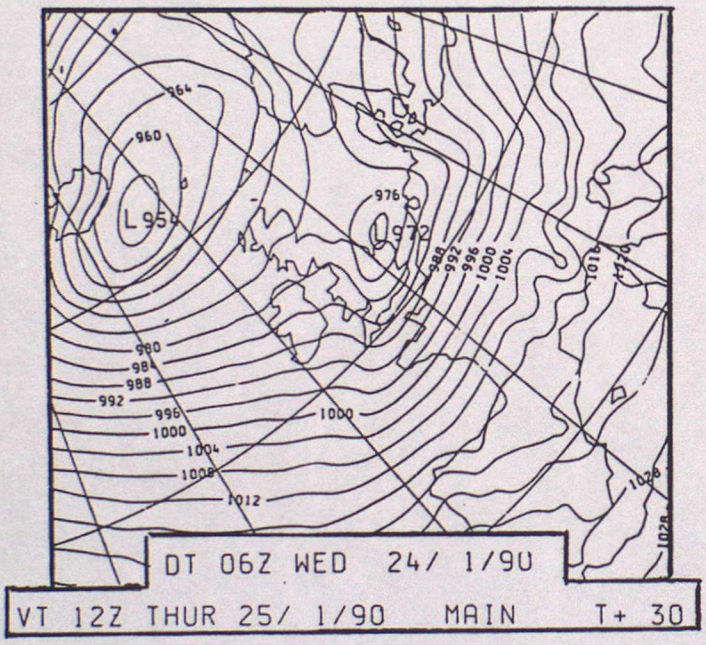

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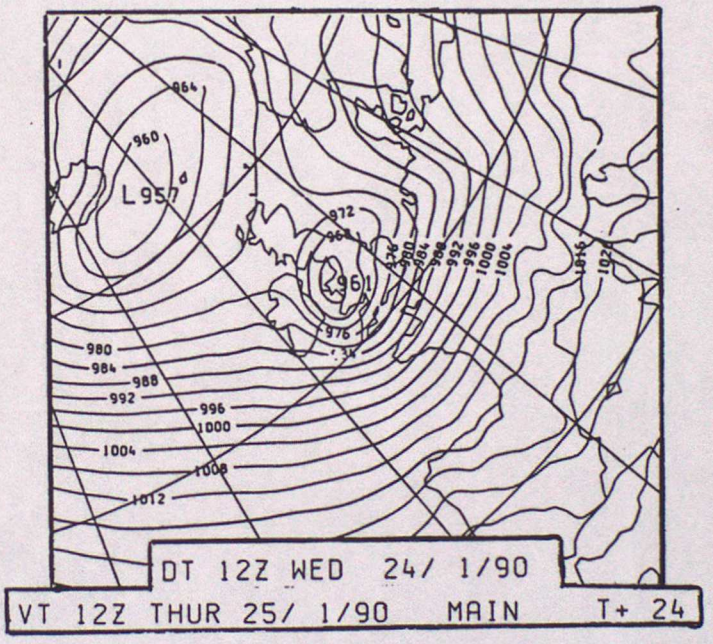


FIGURE 5

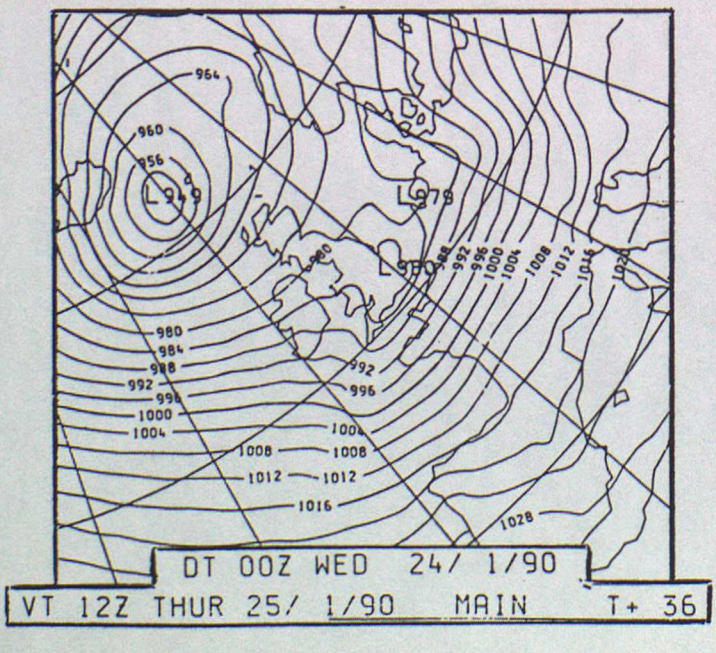
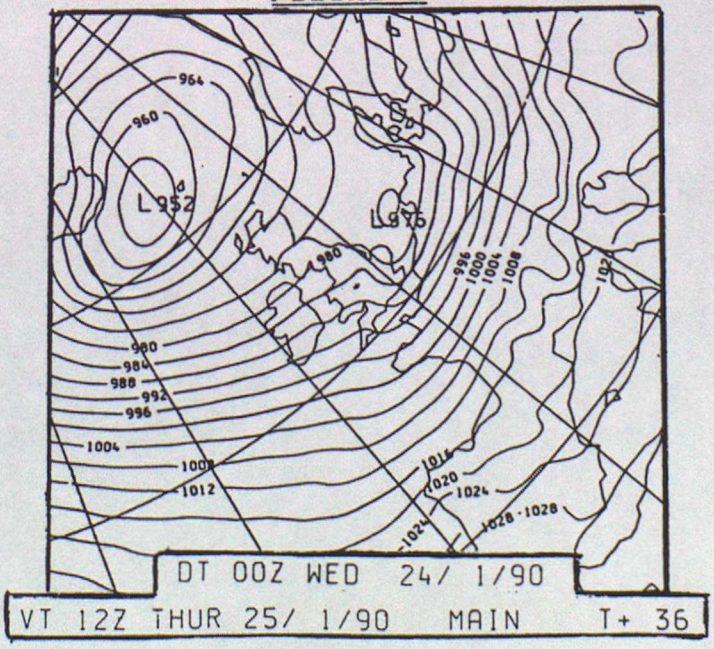


FIGURE 6



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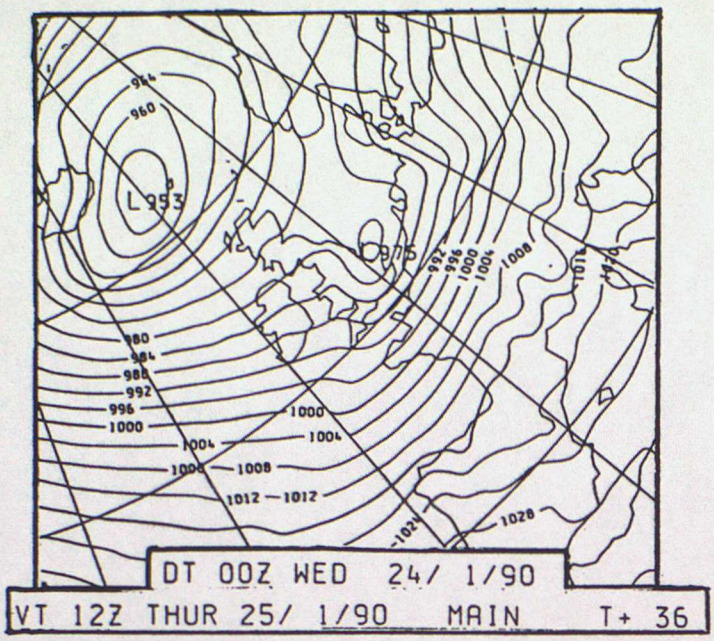

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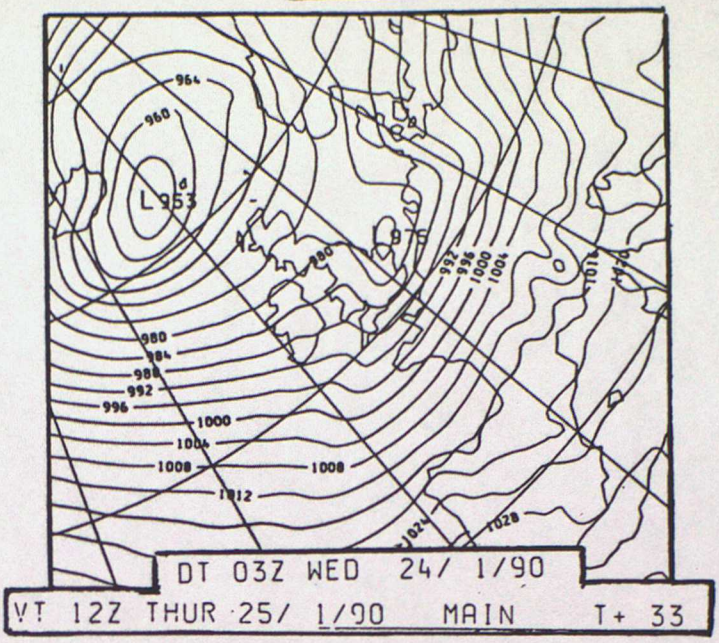

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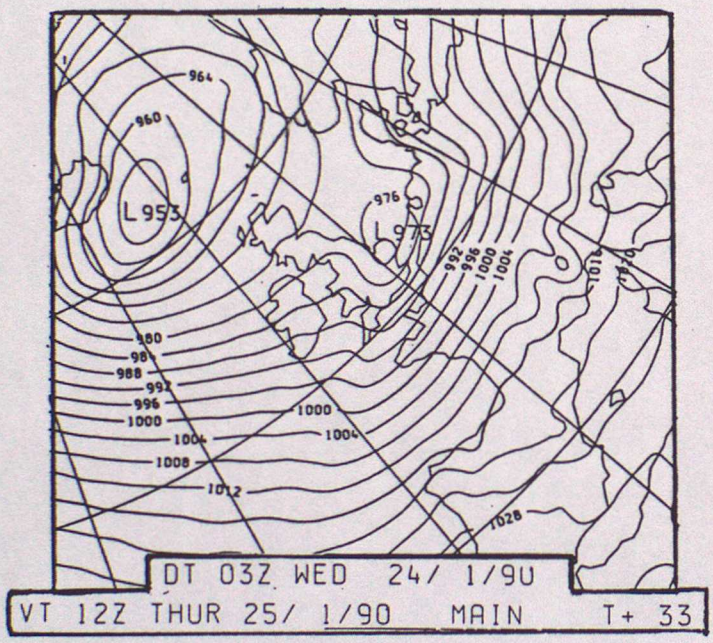

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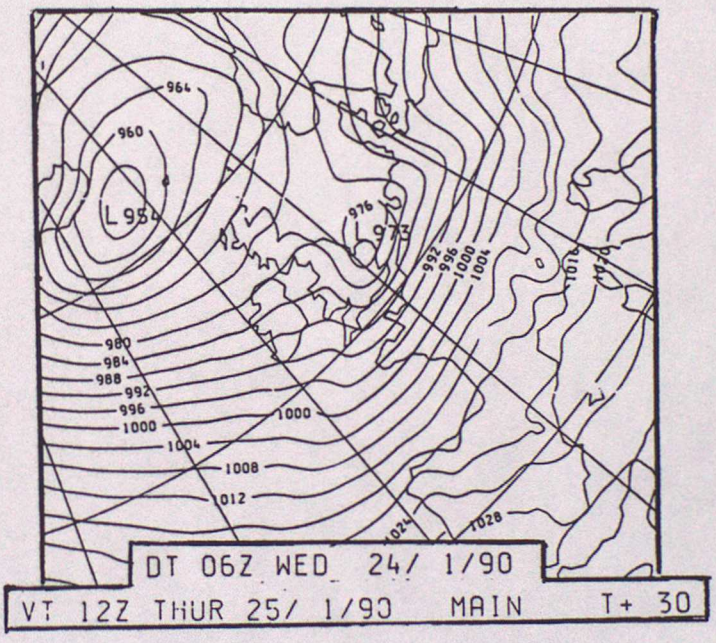

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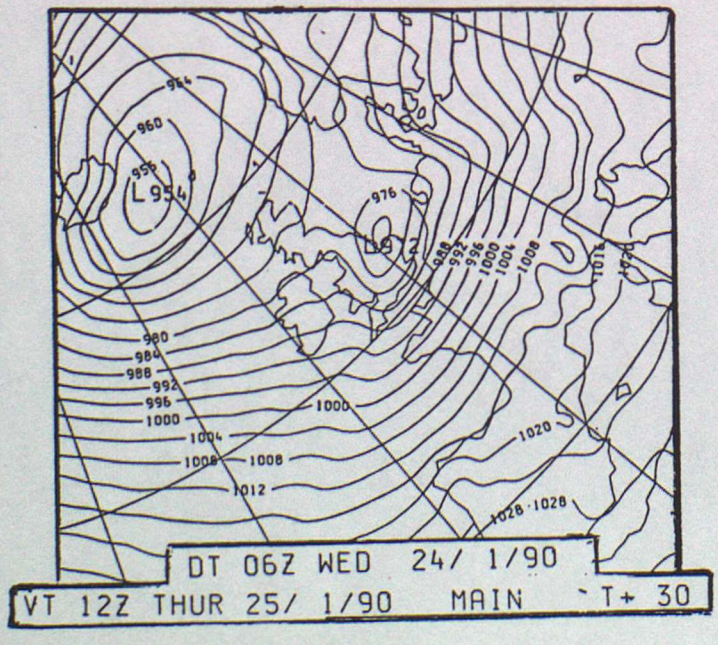

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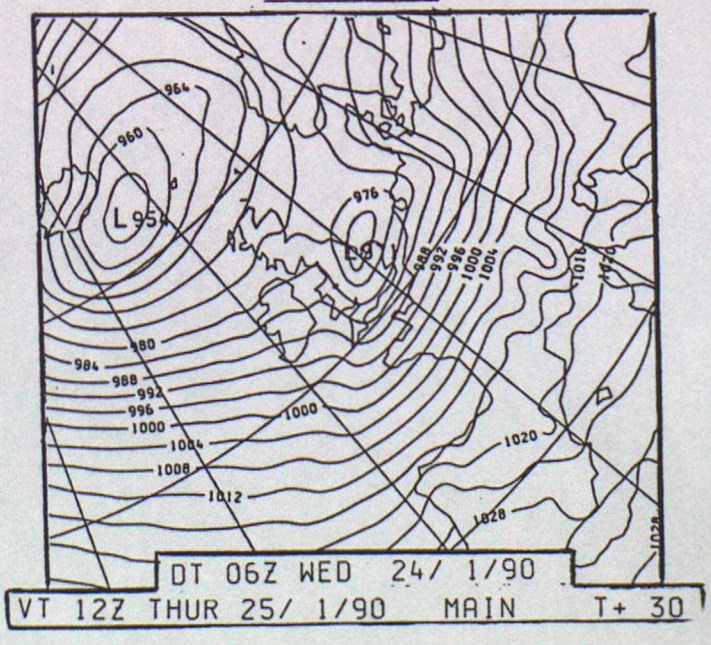

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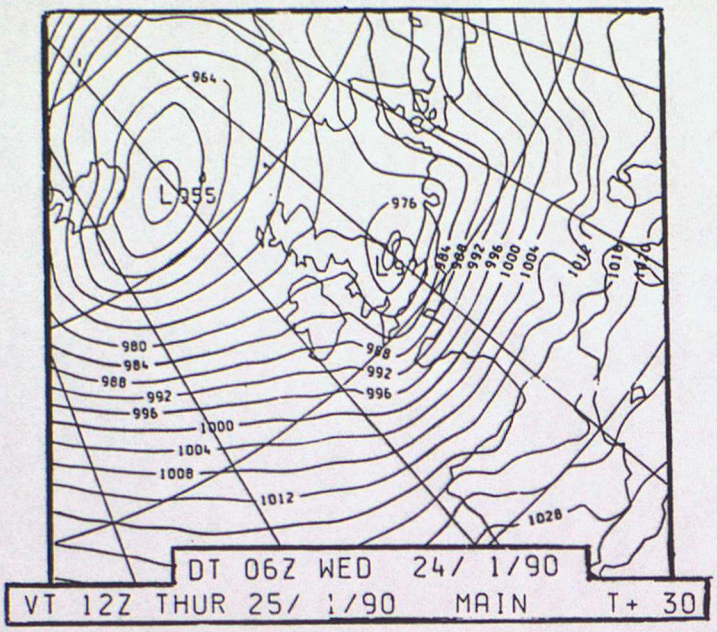

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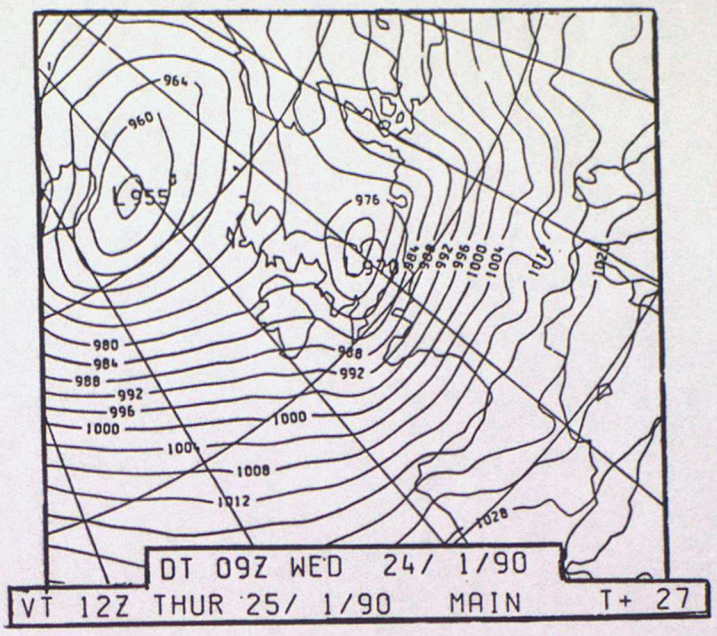

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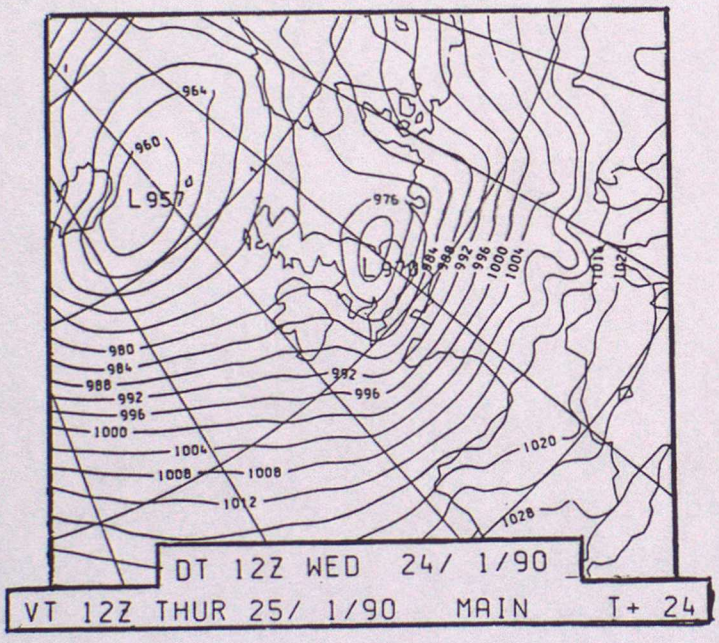
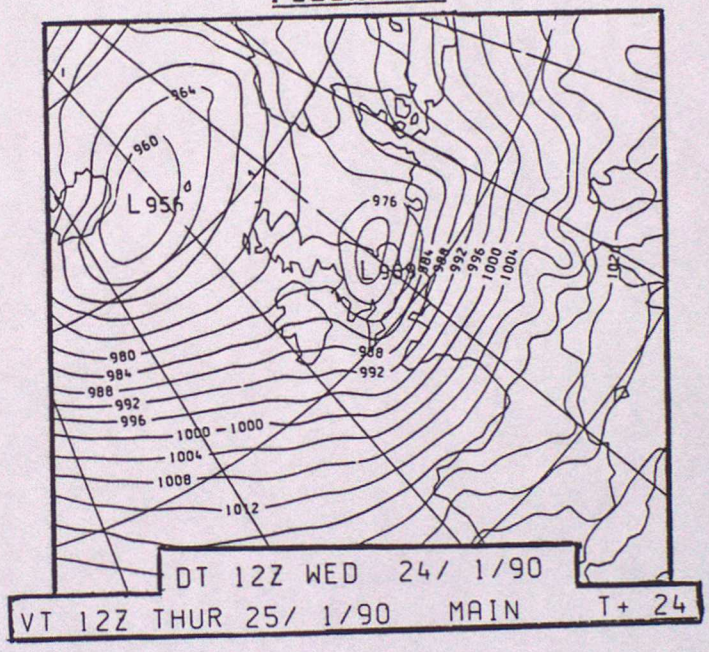


FIGURE 16



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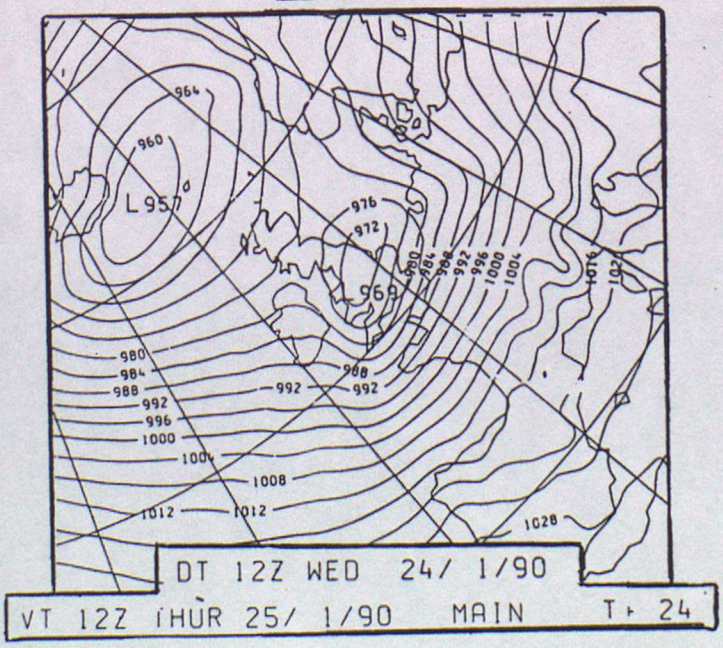

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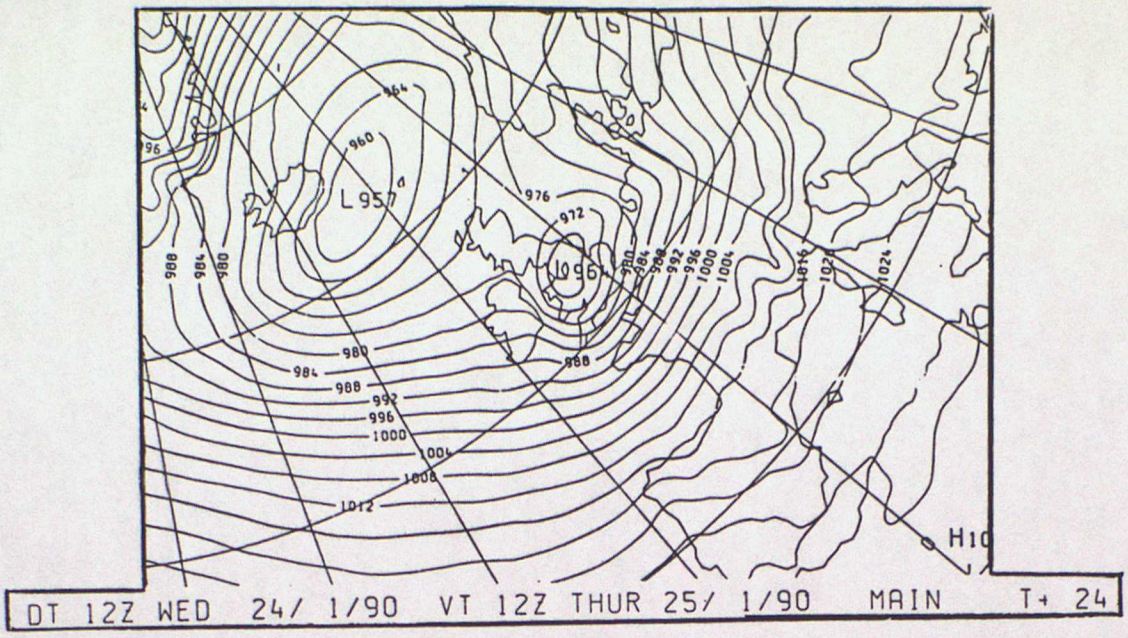


FIGURE 19

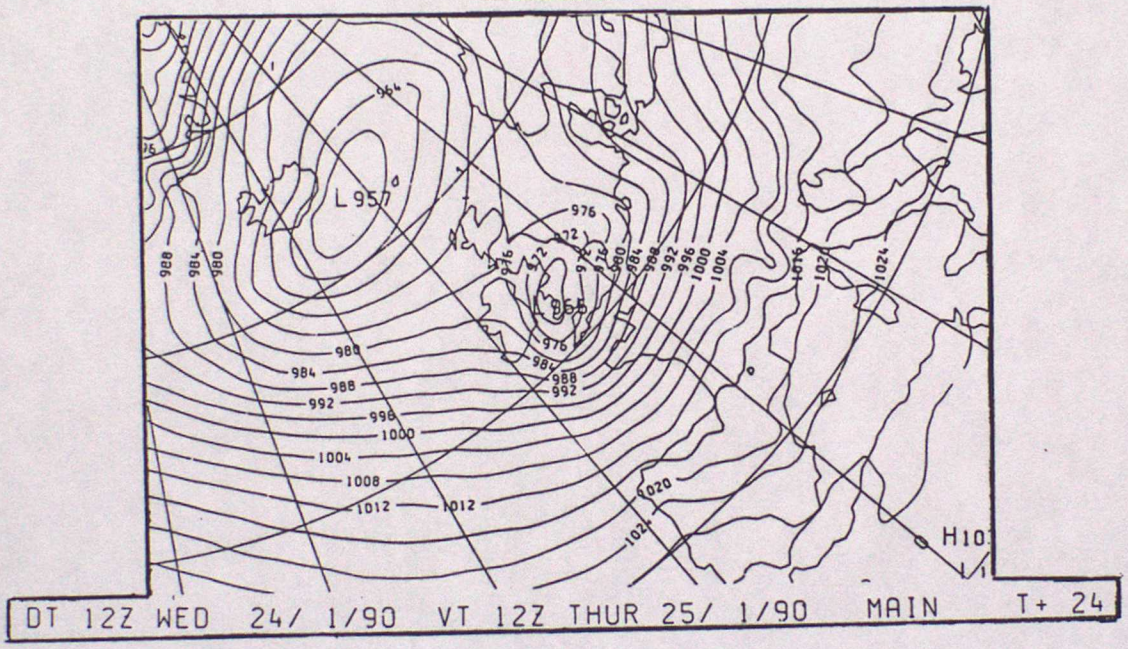
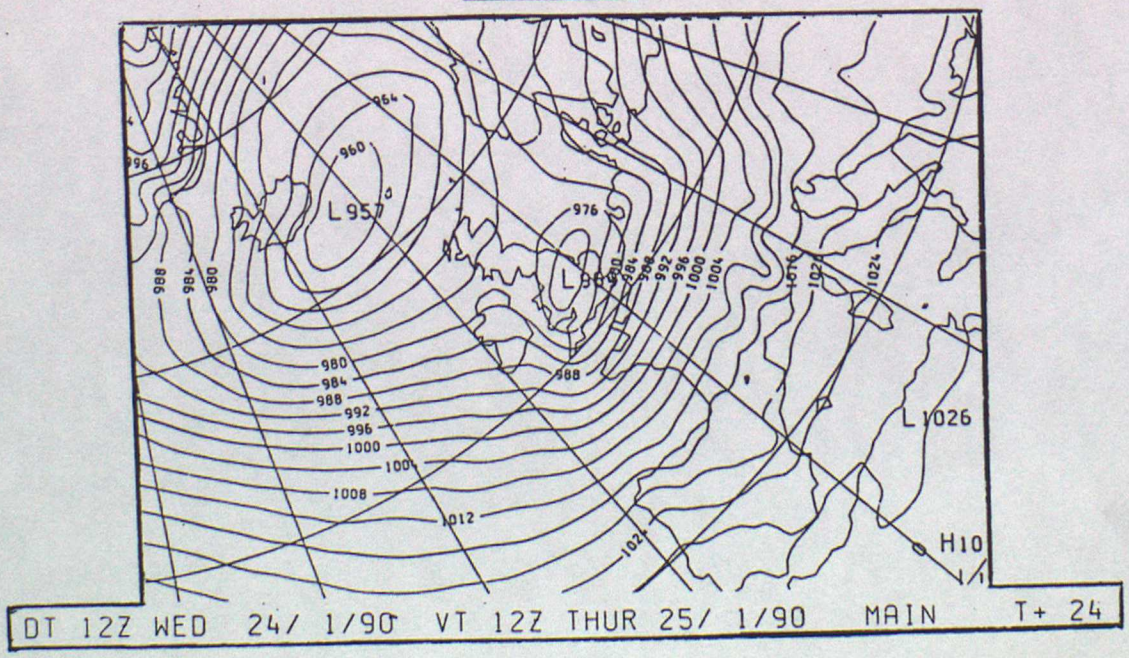
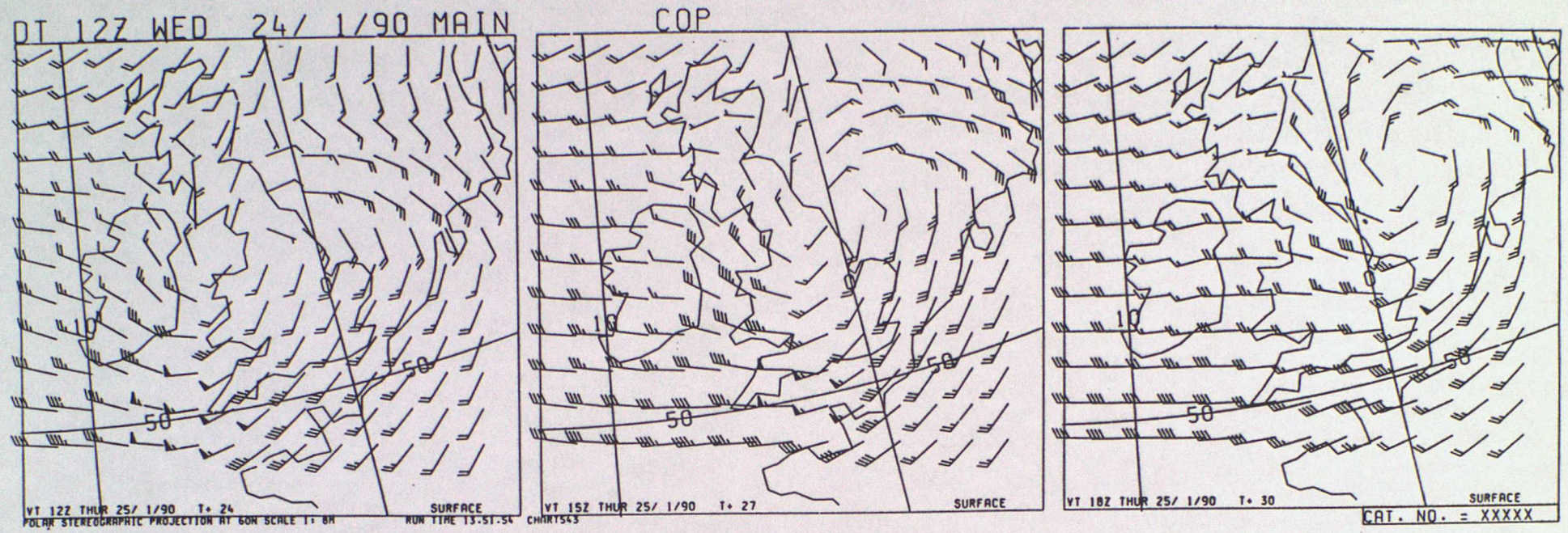


FIGURE 20

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VT 12Z THUR 25/ 1/90 T+ 24
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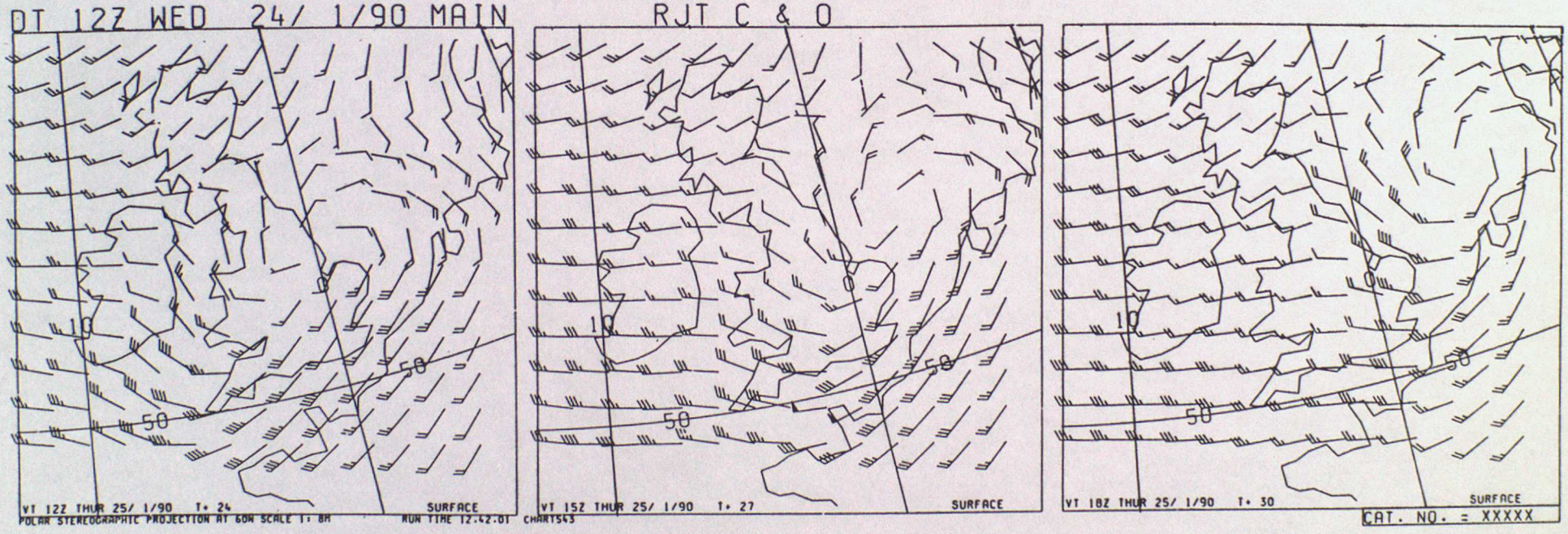
FIGURE 22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